

Figure 1.
Fiber-optic digital communications circuit board.

Contents

Safety Information	2
Product Information	3
Introduction	3
Acceptance and Initial Inspection	3
Handling and Storage	3
Description	3
Kit Parts	4
Connections	5
Operation	5
Fiber-Optic Communications Board	5
Fiber-Optic-To-EIA-232D Converter	5
Fiber-Optic-To-EIA-232D Converter	
Power Requirements	6
Field Installation	8
Board Installation	8
Form 4C Programming Setup	10
Testing	10
Fiber-Optic Cable Specifications	11
Construction	11
Specifications	11
Cable Terminations	11
Maximum Cable Lengths	11

TABLE 1
Ordering Information

Fiber-Optic Communications Accessory, factory installed. Includes circuit board, EIA-232D converter, cables and hardware.	KME4-71-1
Fiber-Optic Communications Accessory, factory installed. Includes circuit board, all cables and hardware (does not include EIA-232D converter KME4-163).	KME4-71-2
Fiber-Optic Communications Accessory, field installed. Includes circuit board, EIA-232D converter, cables and hardware.	KME4-702-1
Fiber-Optic Communications Accessory, field installed. Includes circuit board, all cables and hardware (does not include EIA-232D converter KME4-163).	KME4-702-2



SAFETY FOR LIFE



Cooper Power Systems products meet or exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Cooper Power Systems employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high voltage lines and equipment and support our “Safety For Life” mission.

SAFETY INFORMATION

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- *Is thoroughly familiar with these instructions.*
- *Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.*
- *Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.*
- *Is trained in the care and use of protective equipment such as flash clothing, safety glasses, face shield, hard hat, rubber gloves, hotstick, etc.*

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety Instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER: Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high and low voltage lines and equipment. G103.3

WARNING: Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING: This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage. G102.1

WARNING: Power distribution equipment must be selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install, or maintain this equipment can result in death, severe personal injury, and equipment damage. G122.2

PRODUCT INFORMATION

Introduction

Service Information S280-77-3 provides installation and operating information for the Fiber-Optic Digital Communications Accessory. The fiber-optic accessory provides a permanent digital communications link to the Kyle® Form 4C control.

For installation and operation of the Form 4C control, refer to *Service Information S280-77-1*. For programming instructions refer to *Service Information S280-77-4*.

Read This Manual First

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing and operating this equipment.

Additional Information

These instructions do not claim to cover all details or variations in the equipment, procedures, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your Cooper Power Systems representative.

Acceptance and Initial Inspection

Each accessory is tested and inspected at the factory. It is in good condition when accepted by the freight carrier for shipment.

Upon receipt, inspect the accessory thoroughly for damage incurred during shipment. If damage is discovered, file a claim with the carrier immediately.

Handling and Storage



CAUTION: Equipment damage. Always wear a grounding wrist strap to control static electricity before handling circuit boards. Failure to use this strap may result in circuit board damage.

T253.1

The field kit includes a grounding wrist strap designed to control static electricity (refer to Figure 3). Be certain to wear this wrist strap before unpacking and during the installation of the fiber-optic board accessory. Failure to use a grounding wrist strap may result in damage to the fiber-optic board(s).

The instructions specific to the kit's grounding wrist strap are explained in the following steps.

1. Unwrap the first two folds of the strap and place the exposed adhesive side firmly around your wrist.
2. Unroll the rest of the strap and peel the liner from the copper foil at the opposite end.
3. Attach the copper foil end to a clean area on the grounded back panel inside the control cabinet.

If the accessory is to be stored for any appreciable time before installation, provide a clean, dry storage area. Be careful during handling and storage to minimize the possibility of damage.

IMPORTANT: The fiber-optic board assembly should be stored in a static-proof bag.

Description

A Form 4C control containing a fiber-optic board is able to provide a permanent link for two-way, real-time, digital communications with a remote terminal unit (RTU), telephone modem, or central computer. Temporary digital communication is possible with the recloser control via the data port for limited communications. For more information on the data port communications link, refer to *Service Information S280-77-2*.

With this communications capability, an operator at a remote location can monitor the status of the control and display control data such as: control programming settings, event recorder information, load profile, demand current metering, and recloser duty monitor information. The operator can also reconfigure the control parameters and remotely open or close the recloser.

A pair of standard ST type fiber-optic connectors are mounted on the fiber-optic communication accessory board to provide for customer connection to a digital communications system via fiber-optic cables (customer furnished). Fiber-optic cabling provides excellent electrical isolation and protects transmitted data from electrical interference. An optional fiber-optic-to-EIA-232D converter is available for interfacing between an optical signal and a hard-wired EIA-232 signal, when required.

Refer to the "Kit Parts" section for the specific components of the fiber-optic communications accessory.

KIT PARTS

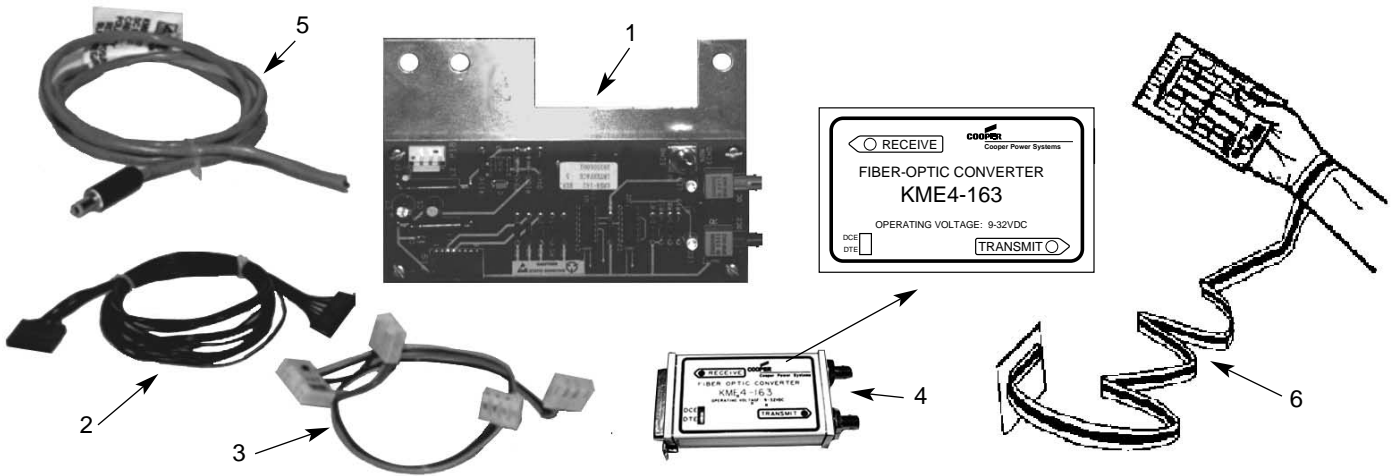


Figure 2.
Fiber-optic accessory kit parts.

TABLE 2
Kit Parts

Item	Part Number	Description	KME4-71-1	KME4-71-2	KME4-702-1	KME4702-2
1	KME4-176	Fiber-Optic Board	1	1	1	1
2	KME4-162	Data Bus Cable	1	1	1	1
3	KME4-177	Power Supply Cable	1	1	1	1
4	KME4-163	EIA-232D Converter	1	--	1	--
5	KME4-207	DC Cable Assembly	1	--	1	--
6	KP2402A1	Grounding Wrist Strap	--	1	--	1
(The following parts are for identification only and can not be purchased separately.)						
		Spiral Wrap, 18"	1	1	1	1
		Wire Tie	1	1	1	1
		Small Wire Ties	3	3	6	6
		Hex Nut, 1/4-20	2	2	2	2
		Lockwasher 1/4	2	2	2	2
		Cable Clamp	2	2	2	2
		Elastic Nut #6-32	2	2	2	2
		Accessory Label	1	1	1	1



CONNECTIONS

The fiber-optic communications accessory board is mounted to the battery support shelf within the Form 4C recloser control using the supplied mounting hardware and interconnecting cables.

Refer to Figures 2 and 4, for identification and layout of main accessory components. Refer to the “Operation” section for external customer connections to the fiber-optics circuit board.

OPERATION

Fiber-Optic Communications Board

The fiber-optic communications board transmits input and output data to and from the Form 4C recloser control to external remote communications devices. Remote communication is possible with a remote terminal unit (RTU) personal computer, or modem equipped device. Customer-supplied fiber-optic cabling provides the data transmission media. The RTU, personal computer or modem equipped drive must be equipped with standard ST type connectors to transmit and receive data using fiber-optic cables.

Refer to Figure 4 for a diagram of communications connections. The fiber-optic communications board converts the output data from electrical pulses to light pulses and transmits the information through the “T” terminal. The board also converts data, received through the “R” terminal, from light pulses to electrical pulses for programming and operation of the Form 4C control.

The fiber-optic-to-EIA-232D converter (KME4-163) can be used to convert the optical signal to an electrical EIA-232 signal for those applications requiring a hard-wired digital signal.

Fiber-Optic-To-EIA-232D Converter

The fiber-optic-to-EIA-232D converter (KME4-163) includes a standard IEEE EIA-232, 25-pin connector on one end and a pair of type ST fiber optic connectors on the other end. The pair of type ST connectors includes one connector for transmitting data and one for receiving data. The EIA-232D connector is adaptable directly to a device that has a 25-pin serial port. For a device that has a 9-pin serial port, a standard DB25 male to DB9 female adapter must be used. This 25-to-9 pin adapter is available at any local computer store.

The fiber-optic-to-EIA-232D converter has three distinctive features. It has a metal enclosure, two miniature LEDs marked TRANSMIT and RECEIVE. The LEDs will blink while the device is transmitting or receiving to provide visual indication that the Form 4C control is communicating. The converter also has a selector switch to change the KME4-163 to either a DTE or a DCE device.

By selecting DTE, the converter is used as a Data Terminal Equipment device. By selecting DCE, the device is used as a Data Communications Equipment device. Computers are DTE devices and modems are DCE devices. The selector switch will allow the converter to be custom fitted to specific applications.

KME4-163 can be ordered either separately or as part of the factory installed kit KME4-71-1 or the field installed kit KME4-702-1 (see Table 2).

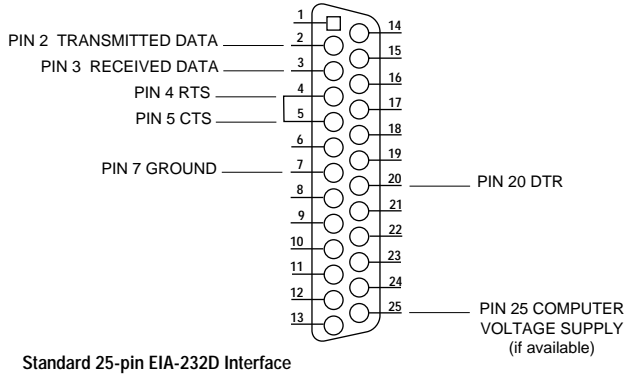
For more information on digital communications with the Form 4C control, contact a local SCADA manufacturer or use the reference data sections listed in Table 3.

TABLE 3
SCADA Reference Data

Reference Data	Description
R280-90-9	Communications Point Data Base – Protocol 2200
R280-90-10	Digital Communications Protocol – Protocol 2200
R280-90-11	Communications Point Data Base – Protocol 2179
R280-90-12	Digital Communications Protocol – Protocol 2179

Fiber-Optic-To-EIA-232D Converter Power Requirements

A 9-32 Vdc power supply is required to operate the fiber-optic-to-EIA-232D converter's electronic circuitry. A power jack is located on the fiber-optic-to-EIA-232D converter. The power supply can come from one of three sources: the KME4-206, 9 Vdc battery holder and cable, optional; the KME4-207, 9 Vdc supply cable, supplied; or the KME4-208, 120 Vac-to-9 Vdc supply adapter, optional.



Standard 25-pin EIA-232D Interface

Figure 3.
Electrical signals used in the fiber-optic-to-EIA-232D converter interface.

The supplied KME4-207 accessory 9 Vdc cable provides non-terminated wires on one end and a power supply connector on the other end. The non-terminated wires can be connected to a standard 9 Vdc battery or a DC power supply from an RTU. The other end of the cable includes a plug that connects to the power jack on the fiber-optic-to-EIA-232D converter. This cable could be used in areas where 120 Vac is not readily available. This may include a remote substation or line recloser installation where connections to a 120 Vac source is difficult or not available.

The optional KME4-206 accessory 9 Vdc battery holder and cable has a battery holder on one end, and a power supply connector on the other end. Any standard 9 Vdc battery will adapt to the battery holder. The other end of the cable includes a plug that connects to the power jack on the fiber-optic-to-EIA-232D converter. This cable could be used in areas where 120 Vac is not readily available.

The optional KME4-208 accessory 120 Vac-to-9 Vdc supply adapter rectifies and steps down a 120 Vac input to a 9 Vdc output. The other end of the cable includes a plug that connects to the power jack on the EIA-232D-to-fiber-optic converter. This cable would be used where 120 Vac power is readily available. This would include any area where a standard 120 Vac outlet is provided.

TABLE 4
Accessory Parts Used to Supply Voltage Signals for Fiber-Optic-to-EIA-232D Converter.

Part Description	Part No.	Type
9Vdc Voltage Cable	KME4-207	Standard
9Vdc Voltage Cable with 9V Battery Holder	KME4-206	Optional
120Vac/9Vdc Converter	KME4-208	Optional

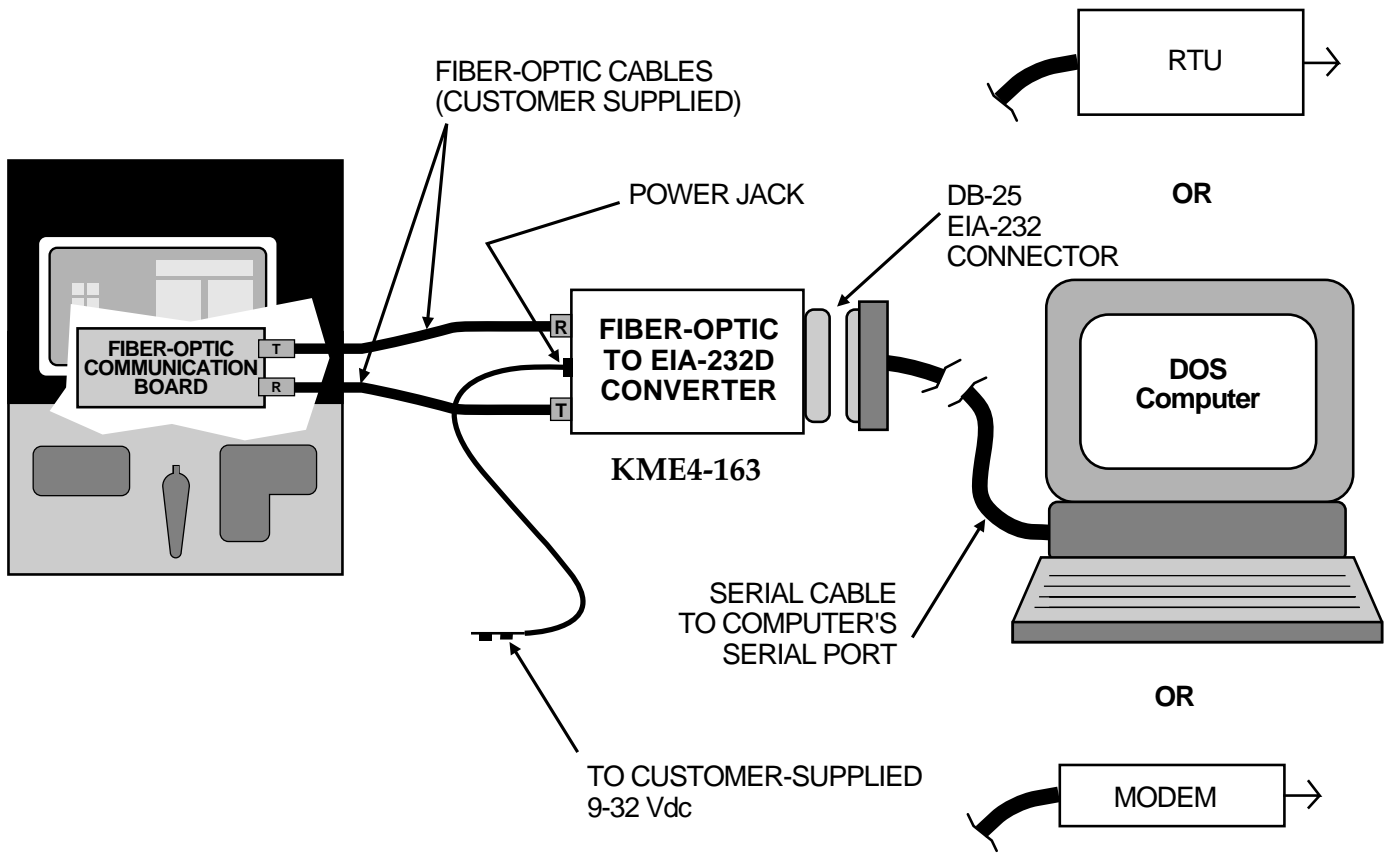




Figure 4. Communication connections.

FIELD INSTALLATION

 **CAUTION:** Recloser misoperation. The control must be removed from service prior to performing any maintenance, testing, or programming changes. Failure to comply can result in mis-operation (unintentional operation) of the recloser. T216.2

 **CAUTION:** Control damage. De-energize both ac and dc power prior to removing or installing any internal connections or circuit boards in the control. Failure to comply can result in damage to the control. T241.1


Board Installation

Refer to *Service Information S280-77-1 Installation and Operation Instructions* for procedures to remove recloser from operation. Further information on Form 4C control operation and programming is contained in *Service Information S280-77-4*.

Refer to Figure 5 for field installation procedures.

1. Remove the recloser from operation.
2. Completely de-energize the control by disconnecting all ac and dc voltages to the control box.
3. Open the control front panel by turning two spring-loaded wing studs.
4. Locate the four wing nuts that fasten the battery hold-down brackets to control box.

NOTE: On later models, there are two additional empty studs to be used for board installation. On earlier models, remove the second and fourth wing nuts and lockwashers. This hardware *will not* be reused for board installation.

 **CAUTION:** Equipment damage. Always wear a grounding wrist strap to control static electricity before handling circuit boards. Failure to use this strap may result in circuit board damage. T253.1

5. Refer to the "Handling and Storage" section on page 3 before continuing with board installation. Carefully remove the fiber-optic digital communications board accessory (KME4-176) from the static-proof bag.
6. With circuit board components facing out, install the board to the mounting studs. Secure board with the supplied 1/4 lockwasher and 1/4-20 hex nuts. Tighten hardware securely.
7. Connect end of data bus cable (KME4-162) to the rear side of the front panel at terminal P20 as shown in Figure 4 and View A-A. Terminal P20 is located directly behind Terminal P4.

NOTE: Both connector ends of data bus cable are identical and are keyed for installation in one position.

Refer to Figure 4 for cable routing.

NOTE: Due to differences in control models, routing of data bus cable (KME4-162) will depend upon configuration of hinge bracket, mounting studs, panel-mounted cable clips, and other variations.

8a. On Form 4C control without supervisory board accessory, install 18" plastic spiral wrap around data bus cable as shown in Figure 4.

b. On Form 4C control with supervisory I/O board accessory installed, Remove the spiral wrap from the from the supervisory I/O board accessory (P4 to P15) cable and intertwine the data bus cable with the I/O board accessory cable.

NOTE: If the supervisory I/O board accessory cable is secured to the inside wall of the cabinet, remove the cable clamps prior to removing the spiral wrap.

9. Connect the other end of the data bus cable to P19 of the fiber-optic communications board.
10. Install the existing spiral wrap around both cables.
11. Install cable clamps over the spiral wrap and secure them to mounting studs, located in the front panel and hinge bracket, with the elastic nuts provided in the kit.

NOTE: Make sure spiral wrap is installed so that cable clamps secure wrap, not cables directly. Make sure the cable routing provides for free play between the hinge for panel opening.

NOTE: If only one stud and clamp are present on swing panel, remove nut and install second cable clamp to stud in opposite direction of existing clamp. Secure clamp with existing nut or use kit provided elastic nut. If hinge bracket is not installed, secure cable clamp to lower hinge mounting stud.
12. Secure the intertwined cables to the inside wall of the cabinet if applicable.
13. At the inside wall of the cabinet, install the large wire tie around the data bus cable and the computer cable from P3.
14. Secure three small wire ties around the data bus cable and I/O board accessory cable, between the P20 location and the spiral wrap around the two cables.
15. Remove the existing power supply cable from terminal P11 on the power supply board, terminal P8 on the standard supervisory board and terminal P18 on the supervisory I/O board accessory (if installed). Discard cable.
16. Install the new power supply cable (KME4-177) to the three terminal locations P11, P8, and P18, as well as terminal P18 on fiber-optic board.
17. Attach the fiber-optic identification label to the inside of swing panel door.
18. Refer to the following programming setup and test procedures for the fiber-optic communications accessory before returning control to operation.

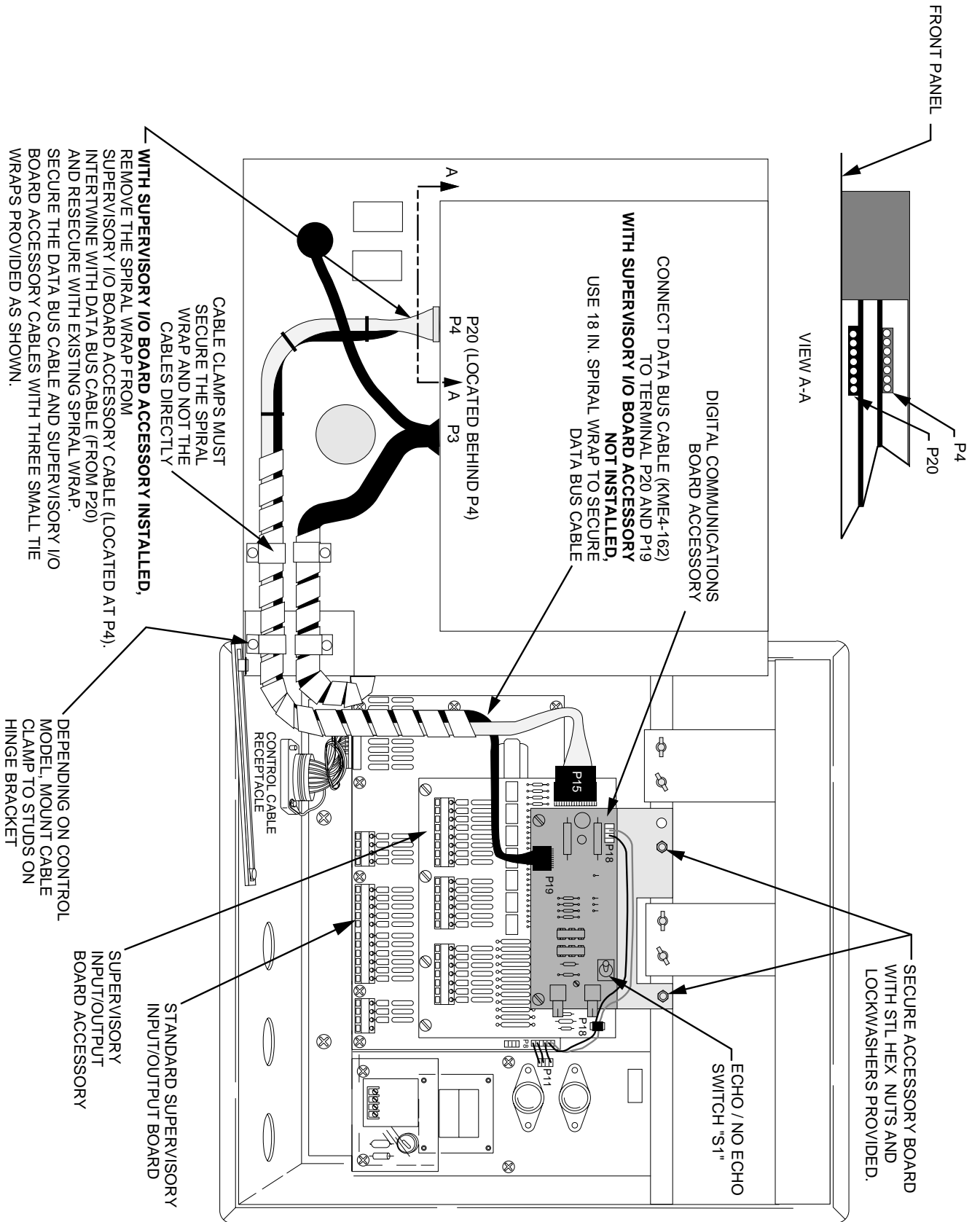


Figure 5. Fiber-optic digital communications accessory installation.

Form 4C Programming Setup

Proper operation of the fiber-optic accessory requires the programming of digital communications access codes 81-85. Follow procedures as detailed in *Service Information S280-77-1 and S280-77-4*.

For communication through the real-time port in a ring configuration, switch S1 (located in the upper right corner of the circuit board as shown in Figure 5) must be set in the ECHO position. In the ECHO mode, the Form 4C control will respond to the Master station by first echoing the command and then sending the response.

Access code 83, Real-Time Digital Communications Port Handshake Mode, defines the handshaking mode and determines the transmit disable delay time. When used with Access code 85, Communications Port Transmit Enable Delay, the message bandwidth can be varied to optimize communications efficiency. Set Access code 83 to 2 to activate the handshaking mode and a 50 millisecond transmit disable delay time.

For communication through the real-time port in a point-to-point configuration, switch S1 must be set in the NO-ECHO mode. The Form 4C will respond to the Master station by sending a response only. Set access code 83 to 0 for no handshaking and no transmit disable delay.

Fiber-optic communication board (KME4-176) assemblies prior to Revision 5 have a jumper (JMP1) located in place of the ECHO-NO ECHO switch (S1). The function of JMP1 on these boards is the same as S1 on later boards. With JMP1 connected, communication is in the ECHO mode. With JMP1 cut, communication is in the NO ECHO mode. Access code 83 should be set corresponding to the communication system configuration as described above.

Refer to the following test procedure before returning the control to operation.

TESTING

Functional testing of the fiber-optic communications board is possible by actual operation of recloser control through an existing operating SCADA system. Prior to returning recloser control to operation, functional testing is possible using Cooper Power Systems' *Form 4C Interface Software (KSPS2)*, Version 2.1 or higher.

Testing Directly To A Personal Computer

- 1. Connect fiber-optic cable to the Form 4C control.**
Attach one fiber from the transmit terminal (labeled T) on the Fiber-Optic Communication Board to the receive terminal (labeled R) on the Fiber-Optic converter. See Figure 4.
- 2. Set the DCE/DTE switch on the converter to DCE.**
See Figure 6.

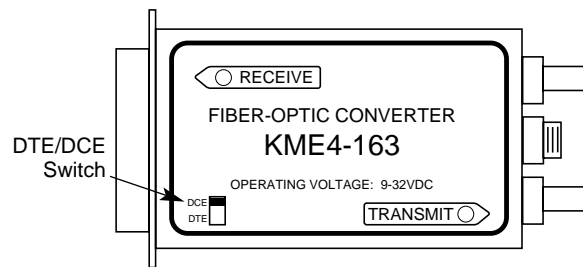


Figure 6.
Fiber-Optic Converter DTE/DCE switch in DCE position.

- 3. Set the ECHO/NO ECHO switch on the Fiber-Optic board to the ECHO position.**
- 4. On the front panel of the Form 4C control, set the following access codes (refer to *Service Information S280-77-4*):**

Access Code 80: set at 4

Access Code 81: set at 4

Note: If Access Code 81 (Real-Time Digital Communications Port Baud Rate) has to be changed, the control must be completely powered down and powered up again for the change to take effect. (See *Service Information S280-77-4*.)

Access Code 82: set at 1

Access Code 83: Set at 3

Access Code 84: Set at 2

Access Code 85: Set at 0

- 5. Set the Form 4C communications as follows:**

Protocol 2179
see Reference Info.
R280-90-12

Com Port: 1
Baud Rate: 4800
Parity: None
Data Bits: 8
Stop Bits: 1

Protocol 2200
see Reference Info.
R280-90-10

Com Port: 1
Baud Rate: 4800
Parity: Even
Data Bits: 8
Stop Bits: 1

Note: Com Port has the default at 1. If another communications port is used, change this setting to match the Com Port being used.

Note: If communicating at baud rate 4800 is too slow, change the rate to either 9600 or 19200. If a change is made to the baud rate, Access Code 81 must be changed. (See *Service Information S280-77-4*.)

Note: If parity is changed, the Protocol must be set to SCADA or changes will not take effect.

Note: When the device type is chosen to match the CPU firmware version; Parity, Data Bits and Stop Bits are automatically set by the program. (See *Service Information S280-77-4*, Access Code 72.)

Contact your local Cooper Power Systems representative for more information on testing software.



FIBER-OPTIC CABLE SPECIFICATIONS

Construction

Multi-mode glass fiber-optic cable suitable for direct burial and/or outdoor use.

Specifications

- 1. Operating Temp. Range: -40°C to +65°C
- 2. Strength Member: KEVLAR®

NOTE: The strength member cannot be steel or any other conductive material as electrical isolation will be lost.

- 3. Inner Jacket: PVC
- 4. Outer Jacket: Polyethylene
- 5. Optical window: 850 nanometers (nm).
- 6. Core size: 62.5 microns (µm).
Other core sizes are allowable; however, they will affect the output power of the optical transmitter. See Maximum Cable Lengths section.
- 7. Attenuation at 850 nm: 3.5 dB/km

Cables with different attenuations are acceptable; however, maximum allowable cable length will be affected. See Maximum Cable Lengths section for an example of how to calculate maximum permissible cable length.

Cable Terminations

“ST” style connectors must be used to mate with the KME4-142 fiber-optic circuit board and the KME4-163 fiber-optic to EIA-232D converter.

Maximum Cable Lengths

- 1. The maximum cable length depends on the output power of the transmitter, the input power level that the receiver can detect as well as the attenuation of the fiber-optic cable.
- 2. The Form 4C control has used two different style transmitters, the HFBR-1412 and the high efficiency HFBR-1414. The HFBR-1414 transmitter went into production on 3-19-91, serial number 200925. The output power of the transmitter is dependent on the fiber-optic core size.

Fiber Core Size	Output Power P(dBm)*	
	HFBR-1414	HFBR-1412
50.0 µm	-20.5	-23.5
62.5 µm	-16.0	-20.0
100.0 µm	-10.5	-16.0
200.0 µm	- 5.5	-11.0

*P (dBm) = 10 log (PµW/1000)

- 3. The Form 4C control uses the HFBR-2412 receiver. Regardless of fiber core size the input power level detection is -24.0 dBm.

4. Cable length calculation example:

Typical 62.5 µm fiber cable attenuation: 3.5 dB/km
 HFBR-1412 Transmitter,
 Output Power: -20.0 dBm
 HFBR-2412 Receiver,
 Input Level: -24.0 dBm
 Safety Margin: -1.5 dBm
 Budget for Cable:
 -24.0 dBm - (-20 dBm) - (-1.5 dBm) = -2.5 dBm

Max. Cable Length = $\frac{-2.5 \text{ dBm}}{-3.5 \text{ dB/km}} = 0.71 \text{ km}$

